

Airborne Conflict Safety Forum
Harry Nelson

AP/FD TCAS and TCAP

A reminder and update

Content

1

AP / FD TCAS Refresher

2

TCAP Review

First commercial aircraft mid-air collision

7th April 1922 over Picardie
Height 492 ft !!



Farman F-60 "Goliath"
Out of Le Bourget



DH -18
Out of Croyden

Introduction

- In 1990's, introduction of TCAS (Traffic Alert and Collision Avoidance System) to prevent mid-air collision
- Today, that safety goal has been largely achieved (However, the risks remain)

- Future risk,



- Increases in traffic
- Widespread RVSM airspace
- Flight Tracks with Next Gen and Sesar

One TCAS side effect: undesired RAs during 1000 ft separation level-off maneuvers

TCAS 7.0 and TCAS 7.1 - Mandate

TCAS II change 7.0

Mandatory since 2000

as per ICAO annex 10,
EASA EU OPS 1.668 and
FAA FAR 121.356

•TCAS II change 7.1

ICAO Recommendation

From Jan-2014 on new A/C
Before Dec-2017 for all others A/C

European Mandate

From Mar-2012 on new A/C
Before Dec-2015 for all others A/C

Content

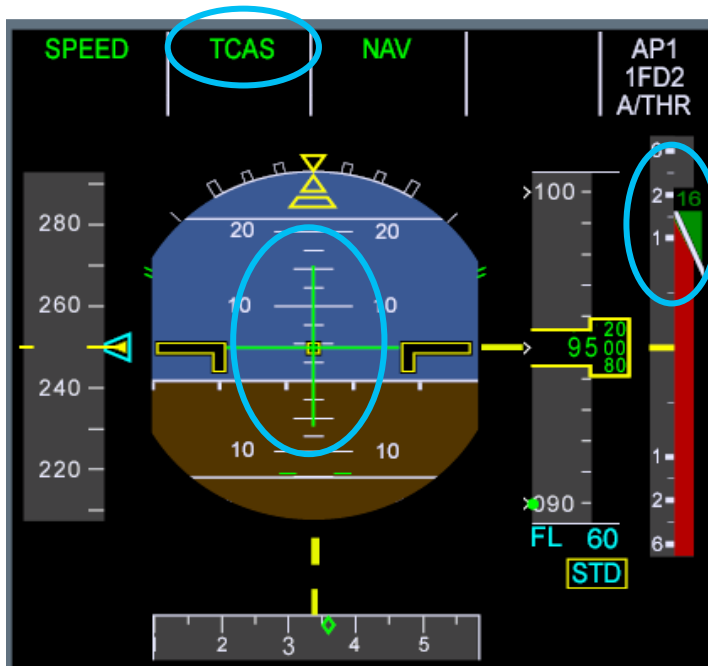
1

AP / FD TCAS Refresher

2

TCAP Review

Auto Pilot / Flight Director TCAS - Refresher



TCAS provides a V/S target to follow on the PFD Vertical Speed Indicator

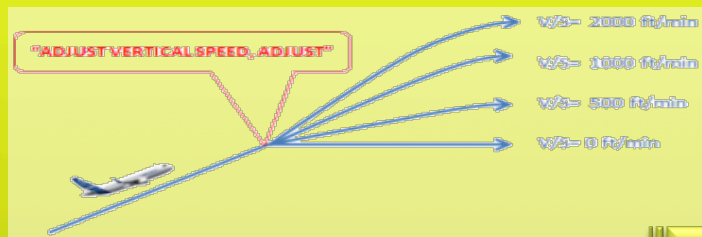
and

The Auto Flight System (AFS) provides a V/S guidance through AP/FD orders

The AP/FD TCAS combines AFS guidance with TCAS orders to provide an automatic V/S guidance in accordance with TCAS target.

TCAS 7.0 Vs TCAS 7.1 – “LEVEL OFF, LEVEL OFF” RA

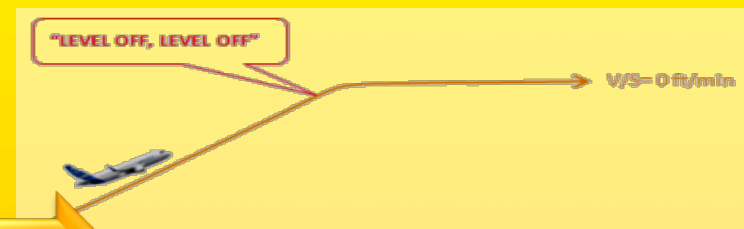
TCAS II change 7.0



**“ADJUST VERTICAL SPEED,
ADJUST”**



•TCAS II change 7.1



“LEVEL OFF, LEVEL OFF”



Replaced by

Alerts on TCAS system

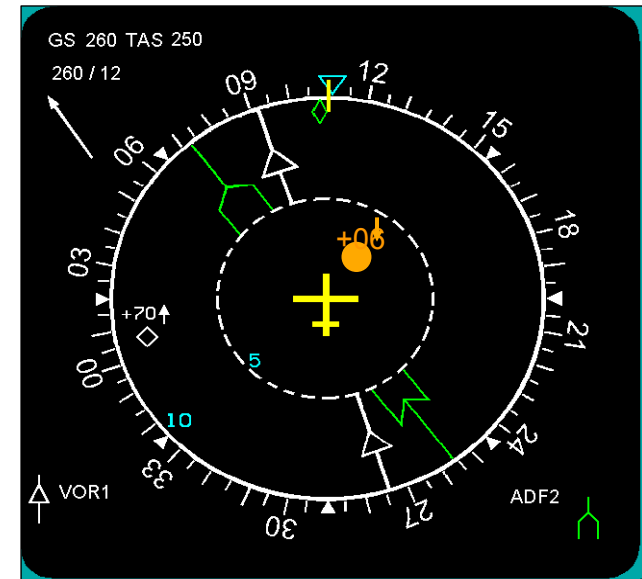
- Traffic Advisories (TA)

- ▶ Audio warning



- ▶ Traffic displayed in amber on ND
- ▶ Triggers TCAS “arming” at this stage

ALT
TCAS



- Operational procedure (TA)

- ▶ No immediate action required (awareness only)

Alerts on TCAS system

- Resolution Advisories (RA)
 - ▶ Different audio warnings, depending on the avoidance maneuver to be performed

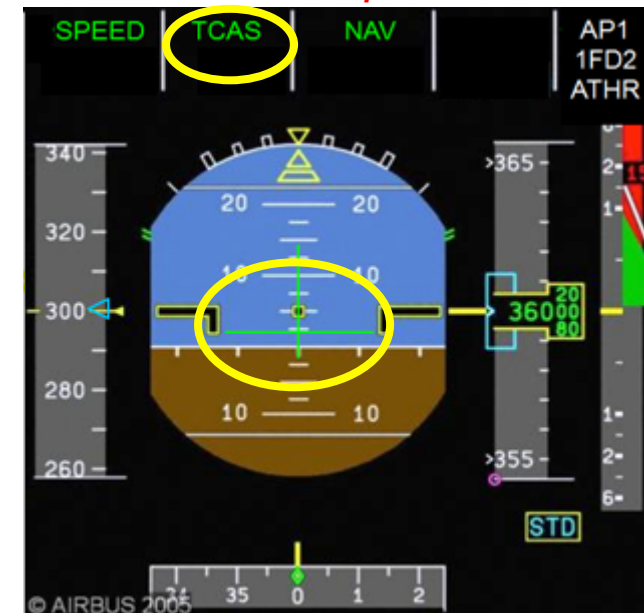


“Level Off”

Red and green areas on the vertical speed scale

- ▶ AP/FD Guidance
- Operational procedure (RA)
 - ▶ **Avoidance maneuver required**
 - ▶ Notify ATC

Red area indicating the forbidden vertical speed domain



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AP / FD TCAS Refresher

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TCAP Review

Airbus solution: TCAP

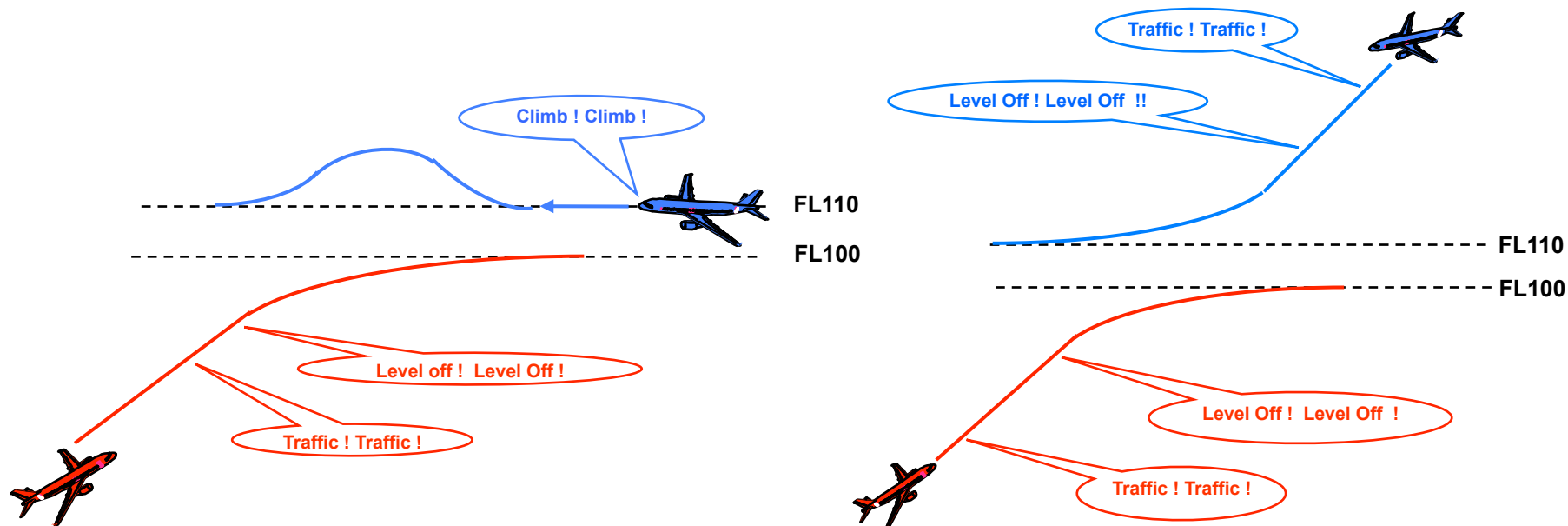
- Objective
 - To reduce the number of operationally undesired TCAS RAs occurring during 1000ft level-off manoeuvres
- Principle
 - Introduction of a new altitude capture law, which decreases convergence rate towards selected altitude when traffic confirmed in vicinity
 - Not a systematic substitute for the conventional altitude capture
 - Activates only when relevant
- Design constraints
 - Retrofittable , Minimum fleet impact, No new threat to HMI levels, Minimum training impact

Airbus solution: TCAP

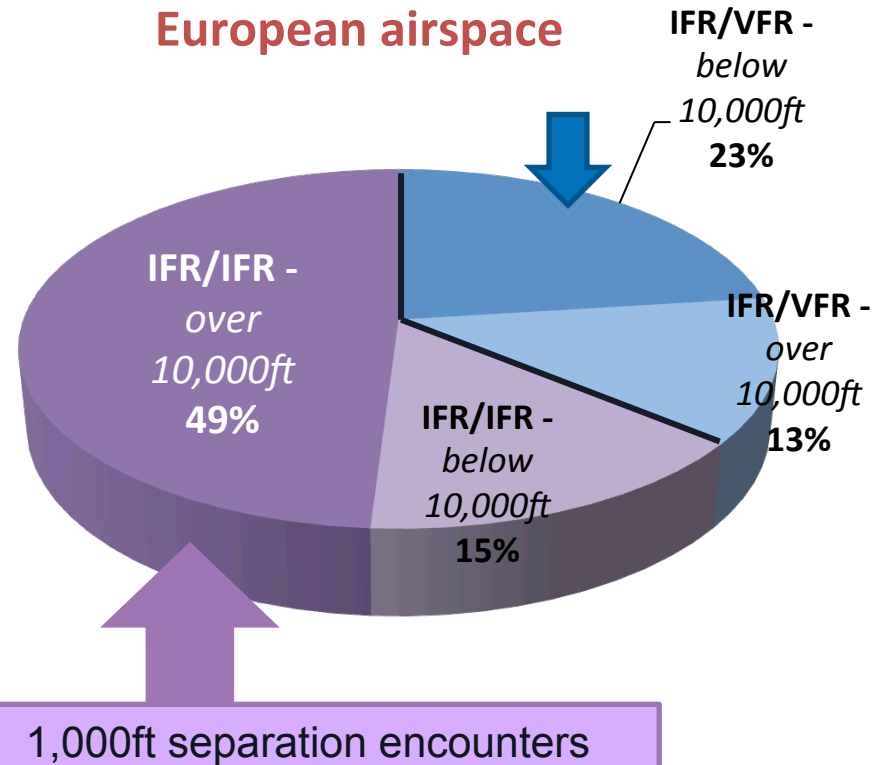
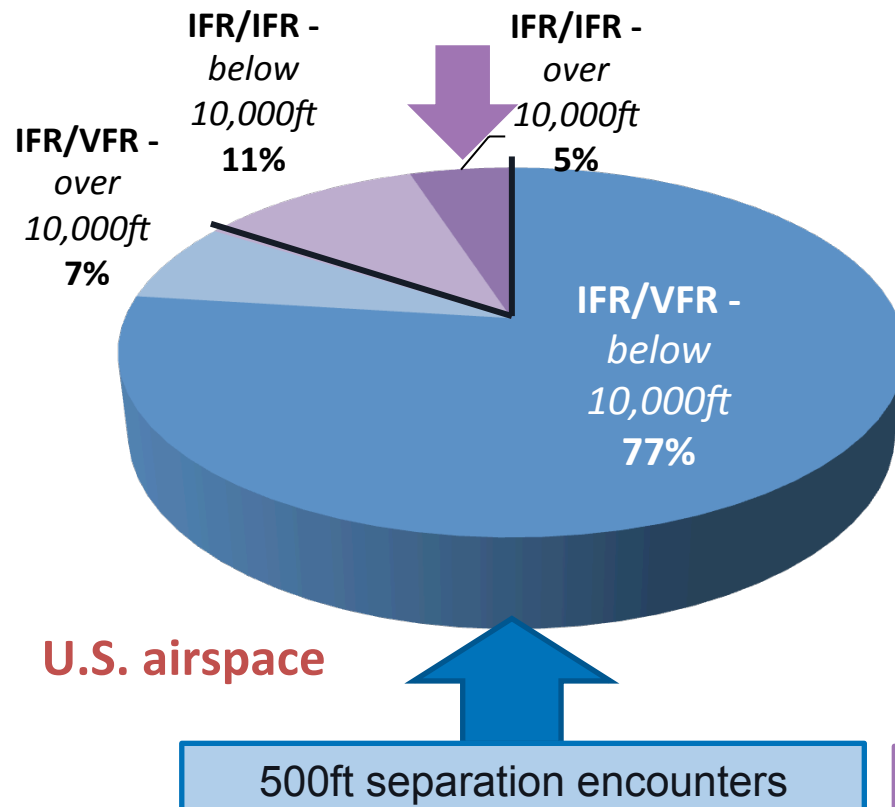
- Activation conditions
 - TA alert triggered by TCAS (i.e. Traffic converging confirmed)
 - Plus necessary pre-conditions:
 - AP and/or FDs engaged
 - A/C converging towards its selected altitude
 - Distance to selected altitude factor

Undesired RAs during level-off maneuvers

- More than 50% of RAs generated during level-off manoeuvres



U.S. & European airspace differences (1/2)

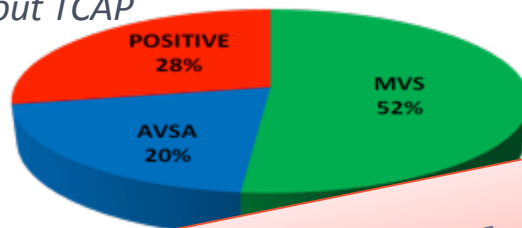


TCAP impact on RAs (4/4)

- Airspace perspective – Type of RAs

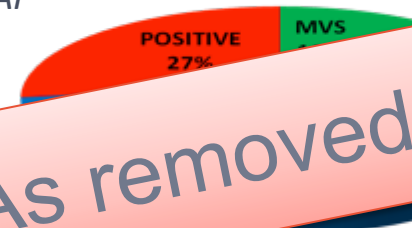
- U.S.

- Without TCAP



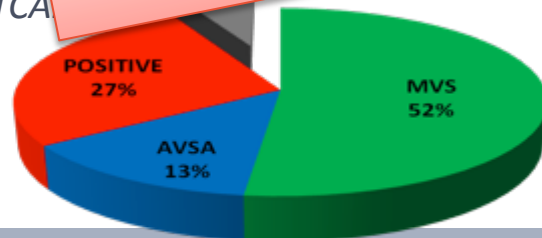
- Europe

- Without TCAP

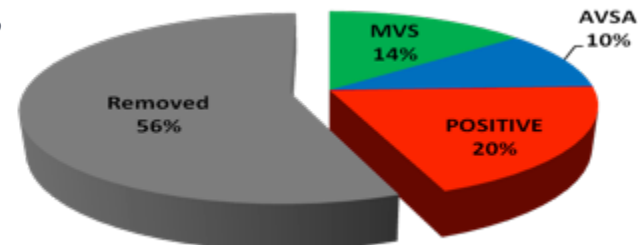


Positive RAs: Climb/Descend
MVS: Monitor Vertical Speed
AVSA: Adjust Vertical Speed

- With TCAP



- With TCAP



Mainly AVSA RAs removed

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